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A Proposal for the Comparison of the Stellar Magnitude Scales of the different Observatories taking part in the Astrographic Catalogue. Second Note. The Bordeaux Magnitudes. By H. H. Turner, D.Sc., F.R.S., Savilian Professor.

1. The proposal referred to in the title was made in March 1909 (*M.N.*, lxix. p. 393), and submitted to the meeting of the Comité Permanent at Paris in April 1909, though it met with very little favour. It is simply this—

> *That the number of images recorded under each unit of the magnitude scale be counted and tabulated.*

Illustrations showing the kind of information obtainable in this way were given from the Oxford, Greenwich, Potsdam, Toulouse, Helsingfors, and Paris results; and it was pointed out that there were evidences of systematic error in all these cases which could best be investigated at the observatory, since some of them might depend on conditions not recorded in the published volumes.

It was also pointed out that these counts did not support Kapteyn's conclusion that the Galaxy was relatively richer in faint stars than the non-galactic parts of the sky, and possibly this fact may be partly responsible for the scant favour accorded to the simple suggestion; for Professor Kapteyn told me in a friendly but frank manner that he could not bring himself to believe the conclusion. The committee, at any rate, decided in favour of a more elaborate investigation, by photographing the region of the Pole on the same plates (and at the same altitude) as selected portions of the zones of each observatory. This procedure is perfectly sound, and the only possible objection to it is that it will delay the completion of the main work, already lamentably in arrear at many observatories—unless the investigation of magnitude scale is itself deferred until the main work is completed. My own view is emphatically that the main work should take precedence, and that it is already more than high time that special measures should be taken to complete it at an early date: and it is therefore in no spirit of opposition to the decisions above quoted (for photographing the Pole, etc.), which I cordially approve, but simply in order to show what can be done pending their achievement, that I recall attention to the very simple procedure already advocated. The present note will show that it will provide valuable provisional information as to the systematic errors of a scale: and if these are ultimately assessed by an independent process, the counts will by no means be wasted, but will be available for the inverse problem of determining the distribution of different magnitudes over the sky.

2. The chief illustration of this paper is taken from the Bordeaux Tome I. published in 1905: zone +17°. The counts were all made by the very kind volunteer help of Miss Riddle. The stars are classed in half magnitudes, by means of a scale constructed at the observatory from measures on the "Pritchard

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types." The process is so simple that no explanation is necessary. The counts were made for each plate separately, and the totals checked with that for the whole plate: but it will be sufficient for the present purpose to tabulate the totals for each hour of R.A., which is accordingly done in Table I. At the foot are given—

First, the sum of each column by itself;
Second, the cumulative sum N′ of all stars up to and including that magnitude;
Thirdly, log N′, the quantity used by Kapteyn, or rather that quantity increased by a constant.

Now under any heading such as 8·0 are doubtless included stars from about 7·75 to 8·25, and thus the values of log N may be taken as corresponding to the headings increased by 0·25 in each case. We proceed to compare the totals with Kapteyn's formulæ.

TABLE I.

Number of Images recorded under each Half Magnitude in the Catalogue of Bordeaux + 17° (*Tome I.*).

Mag. / R.A. h	6·0 and brighter.	6·5	7·0	7·5	8·0	8·5	9·0	9·5	10·0	10·5	11·0	11·5	12·0	Total.
0	3	5	9	12	31	60	106	123	207	187	181	129	88	1141
1	6	4	6	13	19	43	114	185	212	138	150	105	106	1101
2	8	1	4	8	20	42	88	148	185	137	149	65	87	942
3	2	5	5	13	29	52	93	149	240	197	237	175	76	1273
4	3	1	4	17	28	36	85	91	138	91	121	85	91	791
5	6	8	9	31	74	150	397	453	563	506	604	489	252	3542
6	9	1	25	30	91	194	441	514	717	699	927	733	419	4800
7	16	11	30	70	136	208	348	395	536	505	696	647	58	3656
8	15	10	23	37	80	138	203	235	336	292	300	252	35	1956
9	11	9	24	38	78	130	203	187	224	193	222	175	0	1494
10	7	13	18	24	74	80	130	141	187	118	125	90	0	1007
11	13	6	19	21	49	75	126	131	180	129	212	205	0	1166
12	12	7	13	18	42	56	88	102	177	150	235	357	0	1257
13	7	4	20	15	22	50	108	143	190	171	208	208	0	1146
14	9	3	18	25	48	78	111	107	145	121	155	126	0	946
15	9	7	15	15	47	54	111	128	223	207	307	384	8	1515
16	11	7	14	18	35	80	135	149	199	177	321	458	0	1604
17	39	19	29	64	114	163	326	339	446	409	449	436	1	2834
18	19	11	27	39	96	161	326	416	549	444	667	654	0	3409
19	24	12	31	49	124	196	430	518	724	735	876	715	34	4468
20	7	4	22	46	89	158	304	420	613	648	779	431	214	3735
21	6	1	9	15	37	95	230	309	407	442	484	416	169	2620
22	2	4	8	10	23	47	134	217	325	271	361	204	175	1781
23	4	3	4	16	23	39	132	198	261	190	243	190	260	1563
Sum	248	156	386	644	1409	2385	4769	5798	7984	7157	9009	7729	2073	49747
N′	248	404	790	1434	2843	5228	9997	15795	23779	30936	39945	47674	49747	
log N′	2·395	2·606	2·898	3·156	3·453	3·718	4·000	4·199	4·376	4·490	4·601	4·678	4·696	

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3. In *Pub. Ast. Lab., Groningen*, No. 18, Table I., Kapteyn gives log N, the number of stars up to and including each half magnitude *per square degree.* Now we have added together the counts of 180 plates each of 4 square degrees and more. The plates have 26 spaces of 5′ each instead of 24; but the number of stars undoubtedly falls off at the edges, so that the equivalent homogeneous area is a little uncertain. For a reason that will presently appear, let us however consider the whole plate equally good: we must thus subtract from our log N′ to get Kapteyn's log N, the quantity

$$\log 180 \times 4 \times (13/12)^2 = 2{\cdot}927,$$

and the comparison is given in Table II.

Table II.

Comparison of Bordeaux Results with Kapteyn's Formulæ.

Mag.	Log N.				
	Bord.	$K_0{}^{90}$.	$K_0{}^{20}$.	$B-K_1$.	$B-K_2$.
6·25	9·468	9·185	9·312	+ ·283	+ ·156
6·75	9·679	9·435	9·568	+ ·244	+ ·111
7·25	9·971	9·683	9·822	+ ·288	+ ·149
7·75	0·229	9·928	0·074	+ ·301	+ ·155
8·25	0·526	0·170	0·324	+ ·356	+ ·202
8·75	0·791	0·409	0·572	+ ·382	+ ·219
9·25	1·073	0·646	0·819	+ ·427	+ ·254
9·75	1·272	0·880	1·065	+ ·392	+ ·207
10·25	1·449	1·112	1·308	+ ·337	+ ·141
10·75	1·563	1·340	1·548	+ ·223	+ ·015
11·25	1·674	1·565	1·787	+ ·109	− ·113
11·75	1·751	1·788	2·022	− ·037	− ·271
12·25	1·769	2·010	2·254	− ·241	− ·485

4. Under the column $K_0{}^{90}$ is given Kapteyn's general result for all galactic latitudes, and the excess of the Bordeaux result is given under the heading $B-K_1$. It will be seen that this is considerable until we reach about magnitude 10·5. It might be contended that since the Bordeaux zone crosses the Galaxy twice, and lies near it between 22^h and 4^h, we should use Kapteyn's numbers for nearer the Galaxy. Accordingly, under the heading $K_0{}^{20}$ are given his numbers practically for the Galaxy itself, and it will be seen that the excess still exists. There can be no doubt that the brighter stars are assessed too bright at Bordeaux. Inverting the problem, let us find Kapteyn's magnitudes corresponding to the Bordeaux values of log N. We will take the column $K_0{}^{90}$ as the best general approximation.

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Table III.

Kapteyn's Magnitudes from Bordeaux Counts.

Bord. Mag.	log N.	$K_0$90.	B – K.
6·25	9·468	6·82	– 0·57
6·75	9·679	7·24	– 0·49
7·25	9·971	7·83	– 0·58
7·75	0·229	8·38	– 0·63
8·25	0·526	9·00	– 0·75
8·75	0·791	9·56	– 0·81
9·25	1·073	10·15	– 0·90
9·75	1·272	10·59	– 0·84
10·25	1·449	10·99	– 0·74
10·75	1·563	11·22	– 0·47
11·25	1·674	11·50	– 0·25
11·75	1·751	11·64	+ 0·11
12·25	1·769	11·68	+ 0·57

The column B – K gives the error of the Bordeaux magnitudes if we adopt Kapteyn's numbers as a standard. We need not stop to refine upon this comparison because of the systematic difference to which we now proceed.

5. Returning to Table I., the last column (of totals) reminds us that the zone + 17° crosses the Milky Way about 6^h and 19^h. Let us take $5^h - 7^h$ and $18^h - 20^h$ as representing the neighbourhood of the Galaxy: and let us take the two portions $23^h - 4^h$ and $8^h - 17^h$ as representing non-galactic regions, adding together the hourly results to form four groups as in Table IV. It will suffice for our present purpose to retain only a limited number of values of log N.

Table IV.

Values of log N′ for Groups.

Bord. mag.	6·75	7·75	8·75	9·75	10·75	12·25
Kapt. mag.	7·24	8·38	9·56	10·59	11·22	11·68
Non. $21^h - 4^h$	1·76	2·32	2·92	3·51	3·83	4·05
Gal. $5^h - 7^h$	1·71	2·39	3·04	3·56	3·86	4·08
Non. $8^h - 17^h$	2·34	2·84	3·34	3·73	3·98	4·17
Gal. $18^h - 20^h$	1·89	2·46	3·05	3·55	3·86	4·06

From the last column we see that the four groups contain very nearly the same number of stars altogether. If 0·10 be subtracted from all the numbers for the third group, the last two columns become nearly uniform. But there is a considerable excess of bright stars in the third group, though not in the first.

6. If this excess is real, it means a difference between the two sides of the Galaxy, *not* an effect of the Galaxy as compared with the rest of the sky. Now it may quite possibly be real. In Stratonoff's *Études sur la structure de l'univers* (Tachkent, 1900), there is a patch of stars of 6·0 mag. and brighter close to the N. Pole of the Milky Way, near which the Bordeaux zone passes. But the excess is not kept up in following maps, and the figures generally are not such as will accord with the Bordeaux figures.

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It seems more probable (although the idea of a real physical difference is not to be altogether excluded) that there is a systematic error of a seasonal character in the Bordeaux results, and we shall proceed on this supposition for the present. Such an error would appear chiefly as a harmonic of the first order, and would thus be readily distinguishable from a galactic effect, which would show chiefly in the harmonic of the second order (since the Galaxy crosses the zone twice). One obvious physical cause for such an effect is temperature. It has been found that plates are more sensitive in cold weather, and with a fixed time of exposure there should therefore be more faint stars on the plates in the winter. But, keeping an open mind as to the cause, let us analyse the values of log N at the points indicated in Table IV.: viz. intervals of a whole magnitude on the Bordeaux scale, with the exception of the last.

[On reference to Table I. it will be seen that the faintest stars on the plate sometimes appear as 12·0 and sometimes as 11·5 only, and for the final column it is more satisfactory to include *all* the stars on the plate.]

TABLE V.

First Harmonics of log N′, *in terms of R.A.* (α).

Mag.		Coeff. of		Referred to 12·25.		Log N′ for all Stars.
B.	K.	sin α.	cos α.	sin α.	cos α.	Combined.
6·75	7·24	−0·12	−0·19	−0·07	−0·23	+0·24 cos (α − 197°)
7·75	8·38	− ·08	− ·17	− ·03	− ·21	+ ·21 cos (α − 188°)
8·75	9·56	− ·04	− ·13	+ ·01	− ·17	+ ·17 cos (α − 177°)
9·75	10·59	− ·02	·00	+ ·03	− ·04	+ ·05 cos (α − 140°)
10·75	11·22	− ·03	+ ·04	+ ·02	·00	+ ·02 cos (α − 90°)
12·25	11·68	− ·05	+ ·04	·00	·00	

7. From the third and fourth columns it will be seen that the effect is small for the faint stars, but large for the bright ones. What chiefly concerns us is the *relative* effect, and we may accordingly subtract the last coefficients from all the rest, as shown in the fifth and sixth columns. We see that there is a range of 0·48 in the differences of log N′.

Now compare with this the effect ascribed by Kapteyn to the Galaxy. His approximate magnitudes are given in the second column and his extreme values of log N are

		$b=0°$.	$b=90°$.	0° − 90°.
For mag.	7·25	9·88	9·51	+0·37
,,	11·75	2·14	1·38	+0·76
	Difference	−2·26	−1·87	−0·39

8. Hence the systematic differences we have discussed above are greater (0·48 as compared with 0·39) than the extreme effect

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between the Galaxy and its Pole, as determined by Kapteyn. It is clear that before we can arrive at trustworthy conclusions about the effect of the Galaxy, we must investigate this systematic effect, whatever its origin may be. This discussion can obviously be best undertaken at the observatory, and it does not seem necessary to wait for the more elaborate determinations of magnitude proposed at the last meeting of the committee. On the contrary, there may be advantages in delaying this extra work until it is known what is the source of the differences noted; for this knowledge may suggest a particular arrangement of the control investigation. By way of illustration, suppose it is a temperature effect: then there will clearly be advantages in repeating the control plates (or some of them) at widely different temperatures.

9. Before attempting to assign the origin, however, we must remove a small part which would be due to the Galaxy according to Kapteyn. It is easy to find this by writing down the galactic latitude of each hour, and taking out from his tables the difference in log N for magnitudes (say) 7·0 and 12·0. Analysing these numbers we get for the part of the first harmonic due to the Galaxy, at most

$$-0{\cdot}02 \sin \alpha - 0{\cdot}06 \cos \alpha,$$

leaving unexplained in the first row of Table V.

$$-0{\cdot}05 \sin \alpha - 0{\cdot}17 \cos \alpha.$$

It is noteworthy that these expressions are the same in form, and in the numerical ratio of 3 to 1; in other words, it would appear that we could account for the first harmonic by increasing Kapteyn's galactic effect in the ratio of 4 to 1. But apart from the general improbability of such a magnification, there is the objection that the chief effect of the Galaxy should appear in the second harmonic and does not, as we see below.

10. The advantage of working with harmonics is that one harmonic does not affect another. The existence of this systematic effect, whatever it may be, will not affect the second harmonic, which we can calculate without removing the first. (Were it not for this, it would be simpler to work directly in terms of galactic latitude.) Let us first see what the second harmonic should be with Kapteyn's numbers. Taking the differences of log N for magnitudes 7·0 and 12·0 as above, at the galactic latitudes corresponding to the beginning of each hour, we find for the second harmonic,

$$\begin{aligned}\log N_7 - \log N_{12} &= \text{const.} + {\cdot}05 \sin 2\alpha + {\cdot}17 \cos 2\alpha \\ &= + {\cdot}18 \cos 2(\alpha - 8^\circ).\end{aligned}$$

The extreme magnitudes with which we deal in Table VI. are 7·24 and 11·68, differing by 4·42 magnitudes instead of 5·0. Hence we must reduce the coefficient to $+{\cdot}18 \times {\cdot}9 = +{\cdot}16$.

Now analysing the observed values of log N′ just as they stand, we get the third and fourth columns of Table VI., showing the effect

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of the Galaxy on all magnitudes. But what concerns us at present is the extreme *differential* effect, and we therefore subtract the values for 12·25 from all the others as in columns 5 and 6.

TABLE VI. Bordeaux +17°.

Second Harmonics of log N′, in terms of R.A.

Mag.		Coeff. of		Referred to log N′ for all Stars.		
B.	K.	sin 2 α.	cos 2 α.	sin 2 α.	cos 2 α.	Combined.
6·75	7·24	−·13	−·15	+·05	+·07	$+\cdot 086 \cos 2(\alpha-18^\circ)$
7·75	8·38	−·16	−·17	+·02	+·05	$+\cdot 054 \cos 2(\alpha-11^\circ)$
8·75	9·56	−·20	−·18	−·02	+·04	$+\cdot 045 \cos 2(\alpha+13^\circ)$
9·75	10·59	−·17	−·20	+·01	+·02	$+\cdot 022 \cos 2(\alpha-13^\circ)$
10·75	11·22	−·19	−·20	−·01	+·02	$+\cdot 022 \cos 2(\alpha+13^\circ)$
12·25	11·68	−·18	−·22	·00	·00	·000

The effect is thus of the kind indicated by Kapteyn, but little more than half the amount. In view of the systematic error above noticed, we must not lay too much stress on this result until the source of the error is identified: but it is noteworthy that all the evidence hitherto obtained should be in the direction of reducing or annulling the effect of the Galaxy, as indicated by Kapteyn, on the relative number of bright and faint stars.

11. Returning to the error itself, it is worth while considering how far it can be a direct temperature effect. The temperature at which the plates were taken is given in the Introduction to the volume, and the mean for each hour is approximately as shown in Table VII.

TABLE VII.

Temperature (C.) and Mean Date for Mean Plate of each Hour.

(Bordeaux +17°.)

R.A.	Temp.	Date.	R.A.	Temp.	Date.	R.A.	Temp.	Date.
h	°		h	°		h	°	
0·5	10·1	Oct. 23	8·5	6·7	Mar. 6	16·5	16·4	June 18
1·5	6·4	Nov. 17	9·5	8·5	Mar. 16	17·5	17·8	July 6
2·5	6·4	Nov. 31	10·5	7·7	Mar. 11	18·5	20·3	July 16
3·5	1·0	Dec. 9	11·5	8·8	Apr. 5	19·5	19·9	Aug. 7
4·5	1·3	Jan. 2	12·5	9·1	Apr. 15	20·5	19·0	Aug. 22
5·5	1·8	Feb. 6	13·5	12·8	May 11	21·5	15·0	Oct. 19
6·5	5·7	Feb. 18	14·5	17·3	May 31	22·5	14·0	Oct. 16
7·5	6·4	Feb. 27	15·5	15·1	June 1	23·5	12·5	Nov. 4

Now the first harmonic is

$$-15^\circ\!\cdot\!6 \sin\alpha - 0^\circ\!\cdot\!2 \cos\alpha = 15^\circ\!\cdot\!6 \cos(\alpha - 269^\circ),$$

which has its maxima close to the zero-points of the effect exhibited in Table V. It seems therefore quite improbable that the effect is a temperature effect, and its origin must be left quite an open question, which can be best investigated at the Bordeaux Observatory.

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12. Though not connected with the temperature it may still be connected with the date, and accordingly Miss Bellamy * has filled in the mean date for each hour from information given in the volume. For instance, we have to explain why bright stars should be less numerous about 0^h than about 12^h; or what is equivalent, why they should be estimated brighter. Now wind, by shaking the telescope, might enlarge the diameter of the bright stars; and if there is more wind in November than in April and May, this might account for the observed effect. Wind may produce an effect of the kind noted in two ways: it enlarges the diameters of bright stars and makes them appear brighter, while at the other end of the scale it cuts out the faintest stars, the images of which wander about and fail to impress the plate at any point. Bright stars are made to appear brighter, and faint stars fainter.

13. It is natural to inquire whether the magnitudes assigned at other observatories show systematic errors of this kind. At present no other zone has been completely counted in this way except the Oxford zones; and attention has been mainly concentrated hitherto on the differences between different measurers of the Oxford plates. But a random sample seems to show that there is no difference of the same *size* in this case. Take, for instance, the measures made by T.M. in zone + 29°. The values of log N′ down to various limits of measured diameter (d) are as follows:—

R.A.	$d > 29$.	> 21.	> 14.	> 8.	All Stars.
8^h—16^h	2·36	2·71	3·13	3·59	3·69
22^h—2^h	2·40	2·77	3·15	3·59	3·83
Difference	– ·04	– ·06	– ·02	·00	– ·14

14. But if we are content to neglect the differences of personality and take the counts for a couple of zones as they stand; and if further we take all images measured of the same diameter together (neglecting the fact that the quality of the plates varies), then we can tabulate the harmonics for log N′ as follows:—

First Harmonics for Oxford Zones + 26° and + 31°.

d.	Approx. Mag.	Sin α.		Cos α.		Combined.	
		+26°.	+31°.	+26°.	+31°.	+26°.	+31°.
>50	6·5	– ·090	– ·085	– ·005	+ ·093	·091 cos (α + 93°)	·126 cos (α + 42°)
>40	7·5	– ·078	– ·078	+ ·084	+ ·085	·114 ,, ,, 43	·115 ,, ,, 43
>30	8·5	– ·063	– ·082	+ ·080	+ ·083	·102 ,, ,, 39	·117 ,, ,, 45
>22	9·5	– ·094	– ·067	+ ·052	+ ·103	·107 ,, ,, 61	·123 ,, ,, 33
>15	10·5	– ·106	– ·082	+ ·081	+ ·081	·133 ,, ,, 53	·115 ,, ,, 45
All stars	12·0	– ·134	– ·156	+ ·137	+ ·156	·192 ,, ,, 45	·220 ,, ,, 45

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* Incidentally she noticed that there are discrepancies in the dates given for the same plate on pp. 66–67, 84–85, 159, 215–16, 236–67. They can usually be corrected by inspection of neighbouring headings; but it is not clear from the headings alone whether cliché 377 was taken in 1893 as on p. 66, or in 1899 as on p. 67.

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15. It will be seen that the coefficients are fairly steady down to the tenth magnitude at any rate. Excluding the last line, the mean coefficient for $+26^\circ$ zone is ·105 and for $+31^\circ$ zone ·119. Also the epoch is pretty steady, especially in zone $+31^\circ$, which represents later and perhaps more uniform measures. The mean epoch is -55° for zone $+26^\circ$, and -42° for zone $+31^\circ$: mean of both, say -48°. The interpretation here is chiefly that the Milky Way is far richer at $19\frac{1}{2}^{h}$ than at $5\frac{1}{2}^{h}$ where it cuts the Oxford zones. The maximum given by the formula falls at $20^{h}\ 45^{m}$ and the minimum at $8^{h}\ 45^{m}$, but the significance of this difference in epoch need not be discussed here. Of this difference, which is essentially a difference of distribution in *longitude*, Kapteyn's distribution (in galactic latitude only) can take no account. There is, however, a first harmonic resulting from his distribution, owing to the fact that the Galaxy does not cut the Oxford zone symmetrically. For zone $+30^\circ$ the first harmonics are for

$$\text{mag. } 7{\cdot}0 \quad +{\cdot}018 \sin \alpha + {\cdot}094 \cos \alpha = {\cdot}096 \cos (\alpha - 11^\circ);$$
$$\text{mag. } 12{\cdot}0 \quad +{\cdot}040 \sin \alpha + {\cdot}209 \cos \alpha = {\cdot}211 \cos (\alpha - 11^\circ).$$

16. The coefficients are not very different from those found above, but

(1) The epoch differs by $48^\circ + 11^\circ = 59^\circ$, owing to the fact that Kapteyn ignores any effect in galactic longitude.

(2) The rise in the coefficient, which in Kapteyn's tables is gradual, appears in the Oxford results comparatively suddenly near magnitude 10 or 11.

17. Coming to the second harmonic, the figures obtained from Kapteyn's table, declination $+30^\circ$, are

$$\text{mag. } 7{\cdot}0 \quad -{\cdot}040 \sin 2\alpha - {\cdot}107 \cos 2\alpha = {\cdot}110 \cos (2\alpha + 160^\circ);$$
$$\text{mag. } 12{\cdot}0 \quad -{\cdot}084 \sin 2\alpha - {\cdot}225 \cos 2\alpha = {\cdot}240 \cos (2\alpha + 160^\circ).$$

For comparison with these we have

Second Harmonics for Oxford Zones +26° and +31°.

d.	Approx. Mag.	Sin 2 *α*.		Cos 2 *α*.		Combined.	
		+26°.	+31°.	+26°.	+31°.	+26°.	+31°.
>50	6·5	−·145	− 113	−·183	−·178	233 cos (2 *α* + 142°)	·211 cos (2 *α* + 147°)
>40	7·5	−·138	−·145	−·173	−·182	·221 ,, ,, 141	·232 ,, ,, 141
>30	8·5	−·141	−·125	−·190	−·173	·237 ,, ,, 143	·214 ,, ,, 144
>22	9·5	−·162	−·167	−·195	−·160	·253 ,, ,, 140	·231 ,, ,, 134
>15	10·5	−·161	−·167	−·187	−·191	·247 ,, ,, 139	·254 ,, ,, 139
All	12·0	−·173	−·225	−·212	−·182	·274 ,, ,, 140	·289 ,, ,, 129

Neither coefficients nor epochs fit Kapteyn's figures at all well. There is a slight rise in the coefficients, but it cannot be put higher than ·015 per magnitude or ·075 for 5 magnitudes, about half that shown by Kapteyn's figures. The mean epoch for zone + 26° is 141°, and for zone + 31° is 139°, in very good agreement and both differing sensibly from Kapteyn's + 160°.

18. The important point about the features above noticed is that, if real, they are very *local*. The excess of bright stars about $12^h + 17°$, shown in the Bordeaux results, is not shown in the Oxford results for zone + 26°. Again, the superior richness of the Milky Way at 19^h, shown by the Oxford results, does not appear in the Bordeaux results. This richness at 19^h is shown very clearly by Argelander (see Mr. Bellamy's diagram, *Monthly Notices*, vol. lx. p. 16) and therefore by Stratonoff. But it seems to be a local richness of the Milky Way.

Summary.

§ 1. Recurrence to the simple proposal made at Paris in 1909, which may save delay in completing the Astrographic Catalogue.

§ 2. Summary of counts for Bordeaux Dec. + 17° in hours of R.A. (Table I.).

§§ 3, 4. Approximate error of Bordeaux magnitude scale ranging from − 0·8 to + 0·6 of a magnitude, according to Kapteyn (Table III.).

§§ 5–8. There is also a systematic excess of bright stars, near R.A. 12^h.

§ 9. Which is four times Kapteyn's galactic effect.

§ 10. The second harmonic is only one-half that given by Kapteyn's figures. This is not necessarily error in Bordeaux, for other observatories do not support Kapteyn's figures.

§ 11. The error indicated by first harmonic is probably not due to temperature.

§ 12. Is it perhaps due to wind?

§§ 13–17. It is not in the Oxford measures, which, however, do not agree with Kapteyn's figures. The first harmonic is chiefly due to an inequality in galactic longitude, which he ignores; the second does not support his increased richness in faint stars, at any rate, not to the same extent.